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The Protein Requirements of Farm Animals

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CONTENTS

THE PROTEIN REQUIREMENTS OF FARM ANIMALS

Protein materials, like vitamins and minerals, are indispensable for life. Without protein, growth, reproduction, and general health fail. Fortunately for the livestock industry, practically all feeds contain some protein. Farm grains, hays, and pastures all contain appreciable amounts. Many times, however, farm feeds do not furnish sufficient amounts and the right kinds of protein to balance livestock needs completely.

Proteins consist of a number of constituents essential to life known as amino acids. Not all these vital constituents occur in each protein. It may, therefore, be necessary to feed more than one protein to supply all the body requirements, to say nothing of supplying them in the correct proportions. In general, the cereal and cereal by-product proteins, such as those found in corn or wheat, have the poorest quality, or the poorest amino acid make-up. The proteins from animal sources, such as milk and tankage, are the best quality proteins. Intermediate between these groups in quality are the proteins from roughages and oil meals.

In formulating balanced rations for livestock, it is necessary to include those proteins or combinations of proteins that are quantitatively and qualitatively sufficient. How much and what kind of supplement to put with farm grains vary with each species and the purpose for which animals are being fed. These questions involve both efficiency of utilization and cost, and only the results of actual feeding experiments with the different classes of farm animals can answer them.

BEEF CATTLE

Beef cattle are ruminants and can consume large amounts of pasture, hay, or silage. As these are, for the most part, the cheaper feeds, their use should be as extensive as possible.

Many beef cattle, both steers and heifers, are fattened in corn regions. Corn is deficient in protein, and cattlemen who use corn as the foundation of a cattle fattening ration must add protein concentrates to get the most satisfactory results.

Pasture is the natural feed for beef cattle, and while pasture grows well there is no need for concern about additional protein. When maturity, drouth, or frost changes the nutrient content of the pasture, however, supplementary feeds, protein in particular, are necessary, especially for cattle being fattened on pasture.

Legume hays serve as a plentiful source of protein for breeding cows, either wet or dry, if the hays are of good quality and are fed in amounts of 8 to 10 pounds per cow per day.

The nonlegume hays and roughages (timothy, stover, straw, corn silage) should be supplemented with protein concentrates, 1 pound per cow per day for cows nursing calves and one-fourth to one-half pound per cow per day for dry cows.

Silage is excellent feed. Corn silage lacks protein and requires the addition of protein in some form. Legume hays will suffice as the source of protein with corn silage for breeding or growing animals. Some protein concentrate is needed when fattening yearling or older steers on rations that use silage very extensively even if legume hays are fed. About the maximum hay consumption of yearling steers full-fed corn silage has been 3 pounds of legume hay. This amount of hay does not furnish enough protein, and therefore 1½ to 2 pounds of a protein concentrate per steer per day will be a well worth-while addition.

Grass or hay silage is comparable in feeding value to pasture or excellent quality hay and is a roughage not needing additional protein. It is not, however, a fattening feed in the same sense as corn silage.

In the feed lot a protein concentrate is a profitable addition to the ration for calves and yearlings. It is possible to balance a ration for fattening cattle by using legume hay and corn. The corn must be limited to induce sufficient hay consumption to supply the protein, or too long a feeding period or an unsatisfactory finish may result.

Soybean oil meal, cottonseed meal, linseed meal, and tankage are protein concentrates that are recommended for use in beef cattle rations. A unit of protein from linseed meal is probably as efficient as one from any of the concentrates, but linseed meal is frequently high in cost and is seldom recommended as the only source of protein. Soybean oil meal and cottonseed meal are usually enough cheaper to justify their extensive use. Soybeans can be used as a source of protein for fattening cattle, but soybean oil meal is better. Soybeans are not very palatable and are somewhat laxative, making it difficult to keep the cattle "on feed."

A mixture of protein concentrates has proved the most efficient source of protein at the Experiment Station, and mixing two or more of the above-mentioned concentrates is recommended unless prices are considerably out of line.

The most efficient supplement used at the Experiment Station for fattening cattle has been a mixture of 30 per cent soybean oil meal, 30 per cent dry-rendered tankage, 20 per cent cottonseed meal, 15 per cent linseed meal, 2 per cent special steamed bone meal, 2 per cent finely ground limestone, and 1 per cent salt.

Another good mixture is 37.5 per cent soybean oil meal, 37.5 per cent cottonseed meal, and 25 per cent tankage. A mixture of equal parts of two or three of the vegetable protein concentrates will prove excellent.

For fattening calves, the use of 1½ pounds of protein concentrate per calf per day is suggested if legume hay is fed, up to 2 pounds daily per calf if non-leguminous hay is used. Larger amounts, up to 3½ pounds, will increase feed consumption, gains, and finish and may be justified if proteins are relatively cheap.

For fattening yearling steers, the use of 1 to 1½ pounds of protein concentrate daily per steer is recommended if the corn is full-fed and legume hay used. If corn silage is used extensively in the ration, the amount of protein concentrate fed should be from 1½ pounds to 2 pounds daily per steer.

When cattle are fattened on pasture, protein concentrates are a doubtful economical addition as long as the pasture is succulent. If pasture is seriously affected by drouth or killed by frost, protein concentrates should be added as suggested for dry lot feeding.

SHEEP

Of the several food nutrients required by sheep and lambs for health, growth, and reproduction, protein is the nutrient most likely to be inadequately supplied in the average farm ration. Sheep can, fortunately, subsist on rations that are partially deficient in protein, but they cannot give maximum production on such rations. It is unfortunate that there are no definite nor acute symptoms of protein deficiency to cause an awareness that the deficiency exists. Generally, sheep on protein-deficient rations will lack thrift; appear thin in flesh; have dull, ragged appearing, and poorly grown fleeces; drop weak lambs and give little milk to support the offspring; and in many cases seem more susceptible than usual to parasites and disease.

It is a common thought that if a pregnant beef cow will winter well on certain feeds or feed combinations, a pregnant ewe ought to give satisfactory performance if allowed similar feeds. As a matter of fact, the protein requirements of the pregnant ewe, on a comparable weight basis, are fully three times as great as those of the pregnant beef cow. A more accurate comparison is that the protein needs of 1,000 pounds of pregnant ewe are fully as great as the protein needs of a 1,000-pound dairy cow producing 50 pounds of 4 per cent milk. The reason is that improved sheep produce a heavy fleece of wool that is high in protein content. In addition, a sheep reproduces from 8 to 10 per cent of her own weight in dropping a single lamb. High production flocks with multiple birth (twins or triplets) often more than double the usual reproductive rate. A 1,100-pound beef cow producing a 70-pound calf reproduces only about 6 per cent of her own weight. This difference in reproductive rate becomes strikingly significant when it is brought to mind that the ewe accomplishes her job of reproduction in 147 days, whereas the beef cow needs 280 days, or nearly twice as much time. It is essential for maximum production by sheep that the sheep's needs for protein be thoroughly understood.

Summaries of numerous feeding experiments have established that a ewe weighing about 100 to 110 pounds requires from 0.25 to 0.30 pound of digestible protein daily, the larger amount for periods of heavy production and the smaller amount during periods when she is not called on to furnish the essentials for reproduction or nursing. The protein requirement of lambs per unit of weight is not significantly different from that of ewes engaged in reproduction.

How much chance does the average farm ewe or lamb have of getting enough protein to satisfy her needs from the usual farm-raised feeds allowed sheep? The correct answer can be given only when it is known what feeds or combination of feeds is used.

Pasture grass is the usual summertime feed for sheep. If the grass is kept short, fresh, and green, it will usually be adequate for sheep. Pastures containing long, overripe bluegrass, timothy, or wild grass are often protein-deficient pastures on which sheep fail to thrive because of protein deficiency. Companion grazing with other stock, clipping, and in some cases a program of fertilizing will bring about the needed improvement on such pasture.

The harvested feeds usually used for sheep, and given in various combinations, include such roughages as alfalfa, clover, soybean, mixed, and timothy hay, corn stover, corn silage, and sometimes oat straw, and such grains as corn and oats. Wheat and barley are used occasionally.

Combinations of these feeds which include at least 2.5 to 3.0 pounds of legume hay, as alfalfa, clover, or soybean hay, per ewe per day will furnish enough protein for the sheep. If the ration is grain and carbonaceous roughage or roughages, such as light mixed or timothy hay, a definite protein deficiency will exist. In such instances added protein is essential for satisfactory results. The protein-rich concentrates of vegetable origin, as cottonseed meal, linseed oil meal, and soybean oil meal, are excellent sources of protein for supplementing protein-deficient sheep rations. The amount of supplement needed will depend on the combination of feeds being used. Likely 0.3 pound of supplement will be adequate in most cases. If there is a doubt, it would be advisable to consult the sheep extension specialist, The Ohio State University, Columbus, Ohio, or address an inquiry to the Experiment Station.

DAIRY CATTLE

The protein requirement of the milking cow is relatively high because the cow secretes a large amount of protein in the milk. For efficient production there must be at least as much protein in the feed as is secreted in the milk, plus the amount required to maintain the cow's body. As the cow cannot convert protein without some loss, the feed should contain at least 25 per cent more protein than is secreted in the milk. In brief, this is the basis for determining the protein requirement of the dairy cow. Feeding standards that have been devised are useful as a general guide. It is not necessary to compute a ration for each cow in the herd. The adjustment comes from feeding the proper grain mixture with the roughage being used.

In practical feeding the roughage is the foundation of the dairy ration. The grain mixture supplements the roughage and ensures an adequate supply of protein. If a good quality of legume hay, such as alfalfa or soybean, is fed liberally, a low-protein grain mixture, such as corn, oats, and bran or even corn and oats, will be satisfactory. When the legume hay is limited in amount or such hays as red, alsike, or mammoth clover are fed, the grain mixture should be a little higher in protein content. Still more protein is required in the grain mixture when mixed hay is fed. With a low-protein hay, such as timothy, a high-protein grain mixture, or one containing from 22 to 24 per cent protein, is necessary. In the feeding of dairy cows the type of hay and its quality are of the utmost importance. With hay of good quality the amounts eaten by the cows will be much greater and the protein intake from this source much higher than with hay of poor quality. It may happen that a good quality mixed hay or even timothy hay cut early will be more satisfactory than alfalfa hay that is coarse and weedy and has lost most of its leaves and color. The proper evaluation of the quality of the hay and the amounts eaten by the cows is necessary for determining the percentage of protein to use in the grain mixture.

PROTEIN SUPPLEMENTS TO USE

The choice of protein supplements depends to a large extent on the price. A large variety is not necessary. Such supplements as soybeans, soybean oil meal, cottonseed oil meal, linseed oil meal, and corn gluten meal may be used more or less interchangeably, depending on how they may be purchased. When over 300 pounds of protein supplement must be used per 1,000 pounds of mixture, it is recommended that at least two supplements be employed.

Corn proteins, as well as proteins from most of the cereal grains, lack some of the essential amino acids. Fortunately, the legume hays furnish these amino acids and the combination of legume hay with corn or mixtures of farm grains provides a protein supply of good quality. In making up a mixture to be fed with a nonlegume roughage, dairymen should include some protein material from some other plant source, such as soybeans, soybean oil meal, linseed meal, or cottonseed meal.

SUGGESTED GRAIN MIXTURES FOR MILKING COWS

When alfalfa or soybean hays of good quality are fed in liberal amounts:

Ground corn or corn-and-cob meal	500 pounds
Ground oats	300 pounds
Wheat bran	200 pounds
Salt	10 pounds

Total protein 10.7 to 11.3 per cent.

When alfalfa or soybean hays of good quality are fed with corn silage or restricted amounts of legume roughages:

Ground corn or corn-and-cob meal	400 pounds
Ground oats	300 pounds
Wheat bran	200 pounds
Soybean oil meal	100 pounds
Salt	10 pounds

Total protein 14.2 to 14.7 per cent.

When a good clover hay or an alfalfa-timothy-clover mixed hay is fed:

Ground corn or corn-and-cob meal	400 pounds
Ground oats	300 pounds
Wheat bran	150 pounds
Soybean oil meal	150 pounds
Salt	10 pounds

Total protein 15.3 to 15.8 per cent.

When a good quality mixed hay which contains at least one-third clover is fed:

Ground corn or corn-and-cob meal	400 pounds
Ground oats	300 pounds
Wheat bran	100 pounds
Soybean oil meal	200 pounds
Salt	10 pounds

Total protein 17.1 to 17.5 per cent.

When a mixed hay low in clover is fed:

Ground corn or corn-and-cob meal	300 pounds
Ground oats	300 pounds
Wheat bran	100 pounds
Soybean oil meal	200 pounds
Cottonseed oil meal	100 pounds
Salt	10 pounds
Limestone	10 pounds

Total protein 20.1 to 20.4 per cent.

When mature timothy hay or corn stover is fed:

Ground corn or corn-and-cob meal	250 pounds
Ground oats	250 pounds
Wheat bran	100 pounds
Soybean oil meal	300 pounds
Cottonseed oil meal	100 pounds
Salt	10 pounds
Limestone	10 pounds

Total protein 23.4 to 23.7 per cent.

In the sample rations given, either corn or corn-and-cob meal may be used as indicated. The lower of the two protein percentages will apply if corn-and-cob meal is used and the higher if ground corn is used.

For these sample rations the same feeds have been largely employed. Other feeds could be substituted or the proportions changed. For instance, wheat, barley, or hominy could replace some of the corn or oats. Soybean oil meal could be replaced in part or entirely (in some cases) by other protein supplements, such as ground soybeans, cottonseed meal, linseed meal, or corn gluten meal.

AMOUNT OF GRAIN TO FEED

The amount of grain to feed depends on several factors, including the cow's appetite, the type and quality of the roughage, the amount of roughage eaten, and, of course, the amount of milk produced by the cow. The usual practice in feeding grain is to allow 1 pound of grain for every 3 or 4 pounds of milk produced and to vary this rate with the test. It is necessary to feed the higher testing breeds at a higher rate than the lower testing breeds.

FEEDING ON PASTURE

Pastures are highly seasonal in the quantity and quality of the feed that they produce, and dairymen must vary the supplemental feeding to meet the changing conditions of pasture. During May and most of June there is generally an abundance of grass which is high in protein. A low-protein grain mixture, or one containing a 14 to 15 per cent total protein, will be adequate at this time. Later, when the pasture growth decreases, the protein content of the grain mixture must be around 17 to 18 per cent. For part of the summer most permanent bluegrass pasture furnishes very little feed. Cows on such pastures must have just about the same feed that they have in winter.

In general, such supplemental pastures as Sudan grass, and alfalfa and clover aftermaths call for a low-protein grain.

FEEDING THE DRY COW

The dairyman should feed the cow during her dry period so that she will be in a high state of health and carry a surplus of fat at freshening time. Of course the dry cow should have all the good roughage she can eat and, if available, good pasture. A 14 to 15 per cent total protein grain mixture will supply the protein needs during this time, or the regular milking ration will be satisfactory, as a small excess of protein will do no harm. The amount to feed will depend on the size and condition of the cow and her appetite. For smaller cows this may mean feeding 3 or 4 pounds daily, for larger cows, 4 to 6 pounds. Within a week or so of freshening, some good feeders like to change to a light bulky ration made up of ground oats and wheat bran in equal proportions.

FEEDING DAIRY BULLS

A bull in service should be kept in thrifty condition but not allowed to become too fat. Good quality hay should be fed, rather than the refuse hay from the dairy barn. Too much hay should not be given, however, as it is likely to make the bull paunchy. Probably more protein is required for bulls in heavy service than for those in light service. In general, the same grain mixture may be fed to the bull as to the herd.

THE FEEDING OF CALVES AND HEIFERS

As soon as calves will eat them, they should be given some grain and hay of good quality. The quantity of grain should be governed by the amount the calf will clean up in a reasonable length of time. A grain mixture for a calf receiving whole milk or skimmilk may be made up as follows:

Ground corn	400 pounds
Ground oats	200 pounds
Wheat bran	300 pounds
Soybean oil meal (or linseed meal)	100 pounds
Salt	10 pounds

After the calf is taken off the bucket, the feeding of grain and hay should be continued with increased amounts of grain. After a year of age heifers will do fairly well on good hay and corn silage. For the most satisfactory results, the hay should be a legume of good quality and be fed liberally. Under most conditions, however, it will probably be wise to feed some grain; the amount will depend on the size of the heifer and the quality of the hay. The grain fed to the dairy herd may also be fed to the heifers.

SWINE

Hogs are less adapted to bulky feeds than are ruminants. Their rations usually contain large percentages of corn or other grains. All the common grains are deficient in the quantity and quality of their proteins. Some of the grain by-products contain relatively large quantities of protein, but since their proteins are deficient in the same amino acids as those of the grains from which they are derived, they are apt to be relatively ineffective as a sole protein supplement to the grains.

Young or growing pigs require more protein than older or fattening pigs, and confined pigs, more than those running on good pasture. Pregnant sows need ample quantities of protein for the development of their unborn pigs, as well as for their own maintenance and growth. During the period they are nursing their young, sows need still more liberal supplies of protein.

Rations for pigs often are inadequate in other respects as well as in protein. Frequently the protein supplement added also tends to correct these other deficiencies. Hence, although the protein is probably the most important factor, it is not necessarily responsible for all the improvement that may result from the inclusion of a protein-rich feed in the ration.

In six dry lot tests with 62-pound pigs and eight with 134-pound pigs, and in nine pasture tests with 52-pound pigs, adding tankage or a protein concentrate to corn enabled the pigs to reach a 210-pound weight 146, 25, and 45 days earlier, respectively, than similar pigs receiving no tankage. Each pound of tankage fed the young pigs in dry lot, the shotes in dry lot, and the pigs on pasture saved 6.42, 3.74, and 3.20 pounds of corn, respectively.

When the other necessary nutrients, vitamins, and minerals are provided, some of the plant protein concentrates are surprisingly effective as supplements to grain. At times a low price may favor the use of a single protein concentrate. Since, as judged by fewer removals, they have been more healthful and since experiments have repeatedly demonstrated their efficiency, mixtures of animal and plant protein concentrates are usually advisable, particularly for pigs that are not on pasture. Such a mixture may consist of:

Fish meal, tankage, or combination of the two	34 per cent
Soybean oil meal, cottonseed meal, linseed meal, or combination of plant protein concentrates	34 per cent
Ground alfalfa or other leguminous hay	24 per cent
Minerals	8 per cent

If the animal and the plant protein concentrates contain 60 and 41 per cent of protein, respectively, the mixture will have a protein content of approximately 38 per cent. It is suitable for feeding with corn or other grain in separate compartments of self-feeders. If ear corn is fed, pigs may receive 0.5, 0.7, and 0.9 pound of the supplement daily a head, in two feeds, when under 60, between 60 and 120, and over 120 pounds in weight, respectively. These amounts approximate a pound of supplement for every 3, 5, and 7 pounds of corn, respectively.

The use of 65 per cent protein fish meal or tankage and of 44 per cent protein soybean oil meal or cottonseed meal would produce a supplement containing 40 per cent of protein. It is necessary to feed a 40 per cent protein mixture at the approximate rate of 0.45, 0.6, and 0.8 pound daily a head, or of 1 pound to every 3.5, 6.0, and 8.0 pounds of corn to pigs of the three weights as named. An increase in each of the two types of protein concentrates to 37 and a reduction in the alfalfa to 18 pounds would also result in a 40 per cent protein supplement. Possibly then, if the pigs were confined indoors, 1 per cent of fish liver oil or an equivalent amount of vitamin D concentrate in the supplement would be beneficial.

Substituting 10 per cent of dried milk or half as much "liver meal" for an equal quantity of the protein-rich feeds proved helpful for confined weanling pigs but unprofitable for fattening shotes.

Pigs on good pasture need added minerals but no dry alfalfa in their ration. A supplement for them can contain:

Fish meal, tankage, or combination of the two	36.0 per cent
Soybean oil meal, cottonseed meal, linseed meal, or plant protein concentrate	53.5 per cent
Minerals	12.5 per cent

Such a mixture can be self-fed separately, with grain, or can be fed at the rates of 0.5 and 0.6 pound daily a head, in two feeds, to pigs under and over 120 pounds in weight, respectively.

A supplement that is suitable for pigs is also satisfactory for the breeding herd. Sows nursing pigs should receive a pound of 40 per cent protein supplement for every 4 to 5 pounds of corn or other feed. This usually ranges from 1.5 to 2.0 pounds daily a head. Often the ration includes as much middlings, ground wheat, or ground oats as supplement. Unless good pasture is plentiful, a mixture containing ground alfalfa is preferable.

Ample protein and bulk are desirable for sows in winter. A pound of 40 per cent protein supplement to every 6 pounds of grain, or from 0.8 to 1.2 pounds daily a head, depending on the size of the sows, is sufficient. An equal weight of whole or ground alfalfa or other leguminous hay is excellent in winter. A fourth to a half as much oats as other grain is also advantageous.

From 0.6 to 0.75 pound of 40 per cent protein supplement provides sufficient protein for dry sows on good pasture.

POULTRY

The life span of the chicken includes three periods, starting, growing, and laying. Each of these periods presents differences in the amount of protein needed in the ration for that particular stage.

During the starting period, the first 8 to 10 weeks, chicks need an 18 to 20 per cent protein ration, which is generally supplied as a mash with the correct amount of protein. During the next, or growing, period the requirements for protein are less. In order to meet this lessened need, poultrymen may supply a growing ration containing 14 to 16 per cent of protein. Probably a more satisfactory practice to follow is the use of a starting or laying mash containing 18 to 20 per cent protein in connection with the liberal feeding of whole grain.

For egg production, the protein requirement is between 15 and 17 per cent of the feed intake. There are three methods of securing this level of protein consumption by the layers. A complete feed mixture of the desired protein content may be kept before the birds at all times as the sole source of feed. The layers may be given access to an 18 to 22 per cent laying mash, and additional grain in an amount equal to that of the mash consumed may be fed to reduce the protein intake to the desired level. A 24 to 32 per cent protein supplemental mash may be used and ground grains added to make a complete feed of the desired protein content. The high-protein mashes and grain may be fed free-choice, in which case the birds will consume the necessary amounts of each to satisfy their protein requirements, generally 15 to 18 per cent.

The protein content of the turkey starter to be used during the first 6 to 8 weeks is usually between 20 and 24 per cent. After this time a growing mash with a protein content of 18 to 20 per cent is used. In addition to the growing mash the birds should receive all the whole corn and oats they will eat. Aside from the higher protein content of the starting mash, rations for turkeys differ little from those for chickens.

By-products of the meat, milk, and fish industries, and the oil meals from soybeans, cottonseed, and flax are the chief sources of protein for chickens and turkeys. A protein supplement made up from two or three sources is preferable to one made up from any one source. The sources selected may often be governed by current availability and cost. Equal quantities of meat or fish by-products, milk by-products, and vegetable oil meals, especially soybean oil meal, make a very desirable protein supplement for use in the ration of chickens and turkeys.